Regulation of Solar Wind–Magnetosphere Coupling by Ionospheric Outflows

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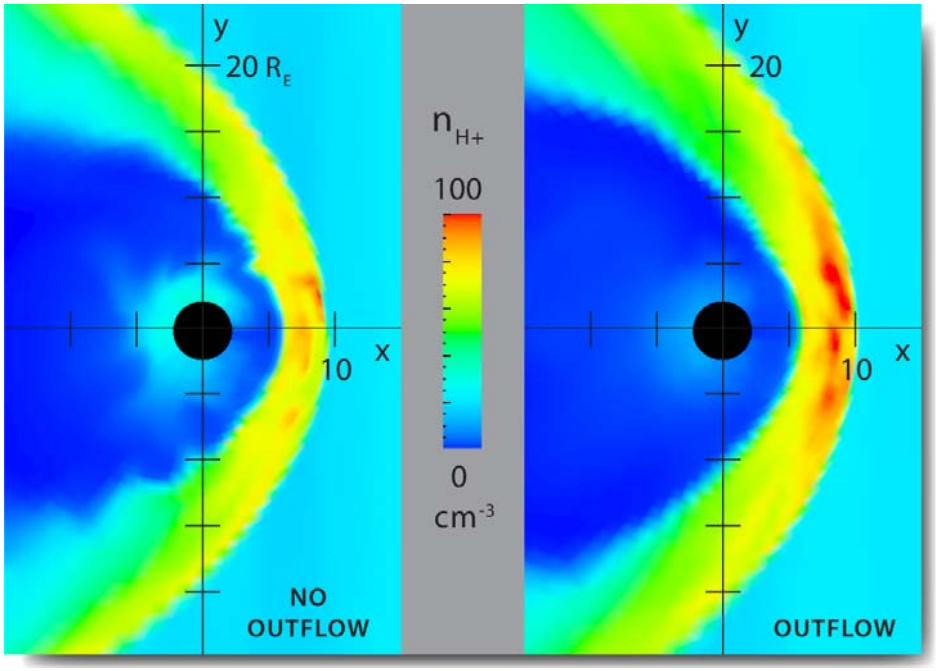
The ionosphere is a persistent source of outflowing plasma and essentially the only source of singly ionized oxygen in geospace. The presence of O^+ in the magnetosphere-ionosphere convection cycle, among other effects, has the capacity to undermine the dayside-nightside balance of reconnection. The inertia of O^+ ions flowing into the nightside merging region from the lobes diminishes reconnection there, without simultaneously moderating the dayside rate. This imbalance cannot persist. Either the nightside merging line must migrate earthward [1] to enable a higher inflow of magnetic flux, or dayside merging must decrease on average. Which state ensues depends on the flux, velocity and location of the ionospheric outflow [2].



It's remarkable that magnetosphere-ionosphere coupling, manifest in ionospheric outflows, can regulate dayside reconnection. How does it happen? First, exhaust flows from nightside reconnection, enriched with O^+, enhance the ring current. The intensified, asymmetric ring current then inflates the flankside magnetosphere relative to the nose region. The dayside boundary is effectively blunted as shown in the figure [2], which compares proton densities at 1634 UT in global simulations of the 31 August 2005 geomagnetic storm including O^+ outflows from the low-altitude cusp (right) and without them (left). The bow shock is forced to move away from the magnetopause, causing more of the upstream magnetic flux to be diverted around the magnetopause rather than piling-up and reconnecting in the subsolar region. Electromagnetic power flowing from the solar wind dynamo into geospace is reduced as dayside and nightside reconnection synchronize at a lower average rate. Convection and, thus, the cross-polar cap potential are also reduced, as is the flux of outflowing ionospheric ions, access of solar wind plasma to the inner magnetosphere, and the amplitude of magnetopause surface waves.

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[1] Wiltberger, M., W. Lotko, J. G. Lyon, P. A. Damiano, V. Merkin (2010), Influence of cusp O^+ outflow on magnetotail dynamics in a multifluid MHD model of the magnetosphere, *J. Geophys. Res.*, doi:10.1029/2010JA015579, submitted

[2] Brambles, O. J., W. Lotko, P. A. Damiano, B. Zhang, M. Wiltberger, J. G. Lyon (2010), Effects of causally driven cusp O^+ outflow on the stormtime magnetosphere-ionosphere system using a multifluid global simulation, *J. Geophys. Res.*, doi:10.1029/2010JA015469, in press